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This research examines two information theoretic measures of media exposure within the same sample of respondents and examines their relative strengths in predicting self-reported aggression. The first measure is the form entropy (DYNUFAM) index of Watt and Krull, which assesses the structural and organizational properties of specific television messages, and the second is a content entropy measure developed by the author, which indexes the entropy of respondents' exposure to categories of television programs. The results of the analyses, compared using linear analysis models, indicate that the form entropy measure has higher predictive power than the content entropy measure in relationships with aggression. Previous information-processing literature suggests that nonlinear, U-shaped relationships are to be expected; nonlinear regression indicates a small, significant U-shaped relationship between content entropy and aggression. This suggests that the relationship between form entropy and aggression may also be U-shaped, and it is proposed that future research using any entropy measures utilize nonlinear models in the theory building process. (Author/RB)

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Alternative Information Theoretic Measures of Television Messages: An Empirical Test*

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ABSTRACT

In recent years there has been an increase in the application of information theory to different aspects of mass communication processes. However, a review of this literature suggests that these developments are at the exploratory stages, and work is needed which tests alternative information theoretic measures for their relative predictive utility. This research examines two information theoretic measures of media exposure from the same sample of respondents and examines their relative strengths in predicting self-reported aggression. The first measure is the form entropy (dynufam) index of Watt and Krull (1972), which assesses the structural and organizational properties of specific television messages. The second is a content entropy measure developed by the author which indexes the entropy of respondents' exposure to categories of television programs.

Krull and Watt (1973) examine relationships between form entropy and aggression in samples of Wisconsin and Maryland 7th and 10th graders. In this paper the same Maryland sample is used, and the same criterion variables are used, except that the content entropy measure, rather than the form measure, is tested. The results of these two analyses, compared using linear analysis models, indicates that the form entropy measure has higher predictive power than the content entropy measure in relationships with aggression. However, previous information-processing literature suggests that non-linear, U-shaped relationships are to be expected; a non-linear regression indicates a small, significant U-shaped relationship between content entropy and aggression. This suggests that the relationship between form entropy and aggression may also be U-shaped, and it is

proposed that future research using any entropy measures utilize non-linear models in the theory building process.

An additional finding of the study arises from the distribution of the content entropy measure. Respondents exhibit a low degree of selectivity with respect to the types of television programming to which they expose themselves. The overall pattern is that respondents expose nearly equally to all program types. Along the lines of future research directions, it is suggested that the functions and gratifications of media use area be approached from an information processing perspective in the development of theory which explains these processes.

Introduction

The past two decades have yielded a very large growth in the application of "systems approaches" to human behavior.[1] An important benefit of these developments is that systemic approaches to communication processes appear to have contributed to greater overlap in the cognitive orientations of those who are involved in the process of doing communication research. Furthermore, at a more macroscopic level, than the relations among communication researchers themselves, the use of this paradigm for the structuring of communication scientists' world view has seemed to contribute to a greater integration of communication theory with physical and general biological theory.[2] This trend is evidenced in the increasing involvement of communication researchers in large multidisciplinary research efforts which cut across the physical sciences as well as the social sciences. While this trend toward greater scientific integration has yet to yield an accumulation of demonstrable pay-offs, the probability of these outcomes occurring appears to be increasing. Evidence for this optimism can be garnered from the acceleration in the use of methodological tools originating in engineering and the "hard" sciences.[3] In this paper, we will focus on the adaptation of one of these tools to communication process research--information theory.

Previous Literature

Most scholars attribute the explication of information theory to Shannon and Weaver (1949). Working within the context of communication hardware, they developed an extensive set of conceptual and mathematical relationships to give

organization to the study of information transmission within physical systems. Central to this development are the concepts of uncertainty or entropy, and information. Uncertainty or entropy increase as the number of alternatives for the occurrence of an "event" increases and as the probabilities of the occurrence of these alternatives become more equal.[4] Information is the reduction of this uncertainty. The greater the extent to which uncertainty is reduced, the greater is the amount of information processed by a system.

Within six years, conceptual linkages had been attempted between the communication engineering area and the more human based area of mass communication. Schramm (1955) sketched the outlines of some applications of information theory to mass communication processes. However, much of his thinking is presented at a descriptive level, and the more theoretically interesting applications to an understanding of the mass communication effects processes were left largely unsculptured.

While discussions of information theory in communication research may have traveled through the networks linking communication scientists together in the ensuing 15 years, no apparent application to the mass communication effects processes appeared in the literature. Perhaps these conceptions, in circulating through the network of communication scientists, finally accumulated enough mass to move from a purely conceptual level to a level of observation, reification, and empirical validation in 1970. Hanneman (1970) performed an experiment to measure the relationships between television message uncertainty, physiological arousal and psychological self-reported measures of aggressive responses. It was found that: 1) with violent content, high uncertainty elicits greater arousal than low uncertainty, but not with non-violent content; 2) high uncertainty in the violent context elicits greater arousal than

the same level of uncertainty in the non-violent context; and 3) high uncertainty elicits greater arousal than low uncertainty among high dogmatics, regardless of content. This last finding suggests the importance of an individual difference variable such as "preference for uncertainty." The self-report measures were unrelated to the uncertainty manipulations.

Watt and Krull (1972) developed a set of procedures for measuring the amount of uncertainty in the form of television programming, using continuous ratio scales of uncertainty (which we will discuss in the metrics section of the paper). In a subsequent paper (Krull and Watt, 1973), they use these measures of television message uncertainty to provide an empirical test for the relative predictive utility of the catharsis, facilitation, and arousal models that relate viewing televised violence and subsequent aggression. Survey data from Maryland and Wisconsin samples of adolescents are analyzed using partial correlations to provide evidence for causal linkages. Their data support a combination arousal-facilitation model. It is found that violent content is largely independent of the entropy of program form in producing arousal. They conclude that both overt content and the form of programs must be taken into account in assessing the effects of exposure to violent content on adolescents.

Another application of information theory to mass communication research is made by Wartella and Ettema (1973). Their primary concern is to measure the relationships among message uncertainty in television commercials, children's attention to commercials, and the degree to which children are perceptually bounded.[5] Using the same measures developed by Watt and Krull, a factor analysis yields two factors: visual uncertainty and auditory uncertainty. Results indicate that greater auditory uncertainty leads to greater

and more stable attention to television commercials over time, while visual uncertainty appears to have little effect on attention.

The studies reviewed to this point have generally focused on the uncertainty of specific televised programming units such as prime time shows or commercials. However, as we will discuss in the metrics section in more detail shortly, the information processed from the media can be conceptualized and measured at a variety of levels of abstraction. One example is reported in Danowski (1974). In this research, the uncertainty of exposure to channels of mediated messages is measured. The more that an individual's use of the various media is equally distributed across media, the greater is the uncertainty of media channel use. A pilot study of a small sample of college students reveals that as media channel entropy increases, the social network integration[6] of individuals increases. This study focuses on the sociological effects of media use uncertainty.

Metrics

Information theoretic measures of the amount of uncertainty in a set of alternatives are content-free. For example, the amount of uncertainty in musical tones, abstract designs, housing patterns, communication networks, and in many other areas, have been reported in the literature. Any time a number of alternatives for the occurrence of an event and the probabilities of those alternatives can be isolated, the abstract measure of the amount of uncertainty and information can be calculated. The number of times uncertainty can be reduced by one-half is a measure of the amount of potential information in a set of alternatives in terms of "bits". Mathematically, this is operationalized by the base two logarithmic function. One of the

basic formulae for measuring information is: $H = -\Sigma p_i \log_2 p_i$; where H is the average amount of information in bits and p_i is the probability of occurrence of an alternative. The $\log_2$ operation is performed for each alternative and the resulting values are summed across each alternative to yield H.

This development provides a set of measures which integrates nicely with systemic views of human behavioral processes. Individuals can be thought of as projecting an organizing perceptual and conceptual structure onto a space/time context, creatively enacting an environment.[7] For environment to "exist," there must be variation across discrete cognitive units. The amount of information processed within an enacted environment by an individual may then be measured by determining the number of cognitive/perceptual units used within a context and the relative frequency of this usage. The information theoretic measures of uncertainty and information provide a useful ratio level, continuous measure of these processes.

A review of the manner in which uncertainty of media has been operationalized in previous research will illustrate both the current exploratory stage and the multi-dimensionality of information measures. Hanneman (1970) did not actually use a formal information theoretic measure of television message uncertainty. Various scenes from prime time television programs were deleted through editing to create differing amounts of uncertainty with respect to the ability of the viewer to predict what would take place within the plot of the programs. A panel of judges was used to predict what was to occur. The degree of accuracy in the prediction of judges was used to operationalize message uncertainty; the less the accuracy, the greater is the uncertainty of the message. Subsequent manipulation checks upon actual experimental subjects supported the creation of sets of messages with high and low amounts of uncertainty.

Watt and Krull (1972) use actual information theoretic measures to measure televised message uncertainty. Set time entropy is defined as the degree of randomness of the time of visual duration of discrete physical locations in a program. Set incidence entropy is the degree of randomness of the appearance of discrete physical locations in a program. Verbal time entropy is the degree of randomness of the time of audible behavior on the part of characters in a program. Verbal incidence entropy is the degree of randomness of the performance of audible behavior on the part of characters in a program. Set constraint entropy is defined as the degree of randomness of the constraints of discrete physical locations in a program, or the relative indoor vs. outdoor time. The final measure, non-verbal dependence entropy is the degree of randomness of the time of non-verbalization by the characters in a program.

These measures were used to code a sample of 158 prime time television shows in July, 1971, using a specially constructed machine with switches and timers. Set incidence was not coded due to technical difficulties. The resulting measured values were then factor analyzed yielding two factors. The set constraint and non-verbal dependence entropy measures load on one factor--"unfamiliarity"; verbal time, verbal incidence, and set time entropy load heavily on the second factor--"dynamics". These two factors are combined into a single measure of form entropy labeled: DYNUFAM.

Wartella and Ettema (1973) use the same measures of Watt and Krull to quantify the entropy of television commercials. A factor analysis performed on the coding of 40 commercials resulted in the emergence of two factors. The first factor is loaded upon heavily by the visual indicators--"visual uncertainty", while the verbal auditory indicators load heavily on the second factor--"auditory uncertainty". Non-verbal dependence entropy loads evenly on the two factors.

Danowski (1974) determined the average number of minutes per month each respondent in a sample used each of the various media through a self-report survey. The number of minutes of media use was totaled across all media and then each particular exposure time for a medium was divided by the amount of total media use. These values constituted the probabilities of exposure to each of the alternative media which were then entered into the basic uncertainty formula. The resultant values represented the amount of entropy in each person's media channel usage.

In the research reported in this paper, yet another measure of media uncertainty is used. It is a measure of the amount of uncertainty in exposure to various categories of program content within the television medium. As such, it is in between in the measures of specific program form uncertainty and media channel uncertainty in terms of the level of abstraction of the units upon which the measure of variability is calculated. Content categories of television programs are more generalized and encompassing than the types of variation of form within particular television programs, while content categories are less generalized and encompassing than the set of alternative media.

The alternative television program categories used here are those reported by McLeod et al. (1971): crime, westerns, adventure-drama, comedy-variety, situation comedy, and game shows. The frequency of exposure to each of these categories is measured and the value for each category is weighted to control for differing numbers of programs within each category. The resultant values are summed and the probability of exposure to each category is determined by dividing the value for each respective category by the total of all values. These data are entered into the following formula:

$$H = \frac{-\Sigma\, p_i \log_2 pi}{\log_2 N}$$

where p_i is the probability of exposure to a particular content alternative, and N is the number of alternative content categories.

This measure develops a ratio of the actual amount of entropy in a set of alternatives to the maximal possible amount of entropy for that number of alternatives. Entropy would be maximal when all the alternatives were equally likely. Hence, this is a measure of relative entropy--actual entropy relative to possible entropy. The resultant values of these operations range from 0.0 to 1.0. A value approaching 0.0 indicates that an individual concentrates exposure in a limited subset of television content, while a value approaching 1.0 indicates that an individual exposes to a wide range of television content.

A Framework for Measures

It may be useful to develop an organizational schema within which to place these various measures of media entropy. We will develop a two-dimensional matrix of some possible uncertainty measures of mediated communication.

The first dimension we will discuss is locus of definition of uncertainty. Two broad categories of these kinds of uncertainty measures are source defined and receiver defined.[8]

Source defined entropy is quantified from the perspective of one who is not within the sample of elements being investigated. It is measured by directly examining the uncertainty of media messages sent by sources, without regard for the manner in which these messages are perceived by users of the media. For example, the measures of Watt and Krull are entirely source defined entropy. The form of what is presented in television programs is measured, rather than the form that is perceived by television users.

Receiver defined entropy is measured from the phenomenology of the user. Hence, perceived uncertainty is measured. This type of measure may present greater difficulties in data gathering and analysis than source defined entropy, but it may have more utility in theoretic development. An example of receiver defined entropy is found in Hanneman's operationalization. A panel of judges rated the uncertainty of programs in the construction of the treatment stimuli, and later, subjects were asked to rate how uncertain they were about the content of messages that they viewed.

A second dimension for classifying entropy measures is the level of abstraction of the measures. Three types of entropy measures can be placed on the continuum of abstraction: form, content, and channel. Form entropy is lowest in abstraction. It quantifies the structural and organizational properties of a message. The entropy of form measures the syntactical and "grammatical" characteristics of message units. For example, in printed material, characteristics such as the relative occurrence of each of a set of alternative sentence structures, paragraph patterns, or topical substructure organizations may be examined. In television, constructs such as those of Watt and Krull (set incidence, physical boundary constraint, non-verbal dependence entropy, etc.) may be used.

Content entropy, higher in abstraction, measures the predictability of such things as the "story line", verbal or digital content, music, etc. Or, it measures the predictability of the presentation of, or the exposure to, categories of content, such as TV: action-adventure, drama, comedy-variety, etc.; or radio: rock, R&B, jazz, classical, news, sports, etc.; with similar examples for other media. The measure used in the research reported in this paper is an example of a content uncertainty measure. Also, Hanneman's measures

are primarily tapping content uncertainty, in that the predictability of the program "plots" are measured.[9]

Channel entropy, highest in abstraction, considers the relative presentation of, or exposure to, mediated channels of communication without regard for the content within these channels. With respect to exposure, the relative predictability of exposure across channels such as television, radio, newspapers, etc., can be quantified. The use of this kind of channel uncertainty measure is reported in Danowski (1974). Another example of channel entropy may be measured by the relative distribution of use of mediated communication devices such as print, telephone, and information retrieval systems by members of large organizations.

These two major dimensions on which entropy measures can be placed--locus of definition and level of abstraction--can be used to construct a 3 X 2 matrix of measures, explified in Figure 1.

Comparing Measures of Entropy

The use of information theoretic measures of media use in communication research is at a highly exploratory stage. As we have seen in the review of the use of these kinds of measures, evidence for their predictive validity is at the initial stages of formation. The testing of alternative measures of uncertainty of media use within the same data base can provide evidence for the relative predictive validity of measures, as well as providing evidence for judging which measures can provide the best basis for theoretic parsimony within particular theoretic contexts at the lowest amount of energy and resources required for measurement.

We noted earlier that Krull and Watt report the use of their form measures of television message uncertainty in a secondary analysis of sample

data including Maryland 7th and 10th graders, in testing three models of the relationships between television viewing and aggressive behavior. These data were originally collected and reported upon by McLeod, Atkin, and Chaffee (1971). In this research we report the use of the content uncertainty measure, calculated across the six categories of programs used by McLeod et al. in examining some of the same relationships as Krull and Watt within the same set of data from Maryland 7th and 10th graders. This then provides a reasonable basis for comparing the relative predictive utility of each of the measures. The hypothesis to be tested in this research, in null form, is that there is no difference in predictive power between the form and content measures of uncertainty of television program use in predicting aggressive responses.

Content entropy measure. In the previous section we described the manner in which this relative measure is calculated. Appendix A provides a listing of the shows within each category, the range of measured frequency of exposure, and the weighting factor assigned to account for differing numbers of shows within each category.

Aggression measure. The index of aggression used in the comparative portion of this research is the same used by McLeod et al. and Krull and Watt which sums together four validated aggression scales into a single overall aggression index: a behavioral delinquency scale, a hypothetical aggressive reaction scale, the Zaks-Walters aggression scale, and the Buss-Durkee manifest physical aggression scale.

Exposure measure. The measure of the amount of overall television viewing by respondents was calculated in the same way as the measure used by McLeod et al. and Krull and Watt. For each prime time series, the respondents were

asked whether they watched "almost always--nearly every week", "often--at least half the time", and "sometimes--at least once or twice" or "never". The first three levels were assigned a weight of 2, 3, and 4 and these values were then summed across all shows.

METHOD

Sample. During April of 1970, McLeod et al. gathered self-report data through questionnaires administered to 229 seventh graders and 244 tenth graders in eight public schools in Prince Georges County, Maryland. This yielded 428 usable questionnaires which were available to the author.[10] The questionnaires included a large number of items dealing with program checklists, a number of aggression measures, and a variety of additional measures of psychological, peer, and family relatiorships.

The sample of shows coded by Krull and Watt included most of the series broadcast by the major networks during prime time. 168 shows from 58 series were coded between the last week of March and the first week of July, 1971. Since in the original research Krull and Watt were comparing two separate samples from different geographic regions, and different shows were aired in each region, only the 40 which overlapped were used in their analysis. Each respondent received a score for the amount of entropy in the programs which were viewed by multiplying the entropy value for the show by the frequency of viewing level. The entropy values for the shows appear in their research report.

Hypothesis testing. There are three common bases for comparison between this research and that of Krull and Watt. First are the zero-order Pearson correlations between viewing exposure, overall aggression, and the

entropy measures. Second is the correlation between the entropy measures and overall aggression, controlling for viewing exposure. And, third is the correlation between viewing exposure and overall aggression, controlling for the entropy measure.

RESULTS

Descriptive statistics appear in Table 1. It should be noted that the content entropy distribution is highly skewed and low in variance. Figure 1 shows the pattern of zero-order correlations between viewing exposure, aggression, and content entropy. The numbers in the brackets are those reported by Krull and Watt between viewing exposure, aggression, and their DYNUFAM measure of form entropy. While the relationship between the form measure of entropy and aggression is positive and significant, the content entropy measure is slightly positive and does not reach significance at the .05 level. The zero-order correlations between content entropy and viewing exposure and viewing exposure and overall aggression are positive and significant.

It might be expected that the correlation between viewing exposure and overall aggression would be identical in both analyses, since they are performed upon the same data base. However, Krull and Watt base their measure on 40 shows which were common to the two samples with which they originally dealt, while the present research is based on the use of 65 prime time shows available to the Maryland sample. This would indicate that the 40 shows selected by Krull and Watt may be biased toward those shows associated with more aggressive behavior on the part of viewers. The use of the full range of shows indicates a substantially weaker relationship between viewing exposure and overall aggression.

When viewing exposure is controlled for, the first-order partial correlation between content entropy and overall aggression becomes essentially zero, while for Watt and Krull it is moderately positive. Controlling for content entropy yields a significant positive relationship between viewing exposure and aggression which is nearly equivalent to the value obtained by Krull and Watt. Both the form entropy measure and the content entropy measure facilitate the relationship. The correlation between viewing exposure and aggression decreases when the effects of entropy are "removed." However, the facilitation is more substantial with the form measure. The patterns observed in these partial correlations indicate that the form and content entropy measures operate in different ways. It appears that the content entropy measure has little linear relationship to aggression and the null hypothesis is rejected.

It is typically the case with research involving information processing, that U-shaped relationships are found with criterion variables.[11] For example, extremely low and extremely high levels of entropy in stimulus configurations are not highly preferred by experimental subjects, while moderate levels are most preferred; at extremely low and high levels of input load, output efficiency of systems is low, while at moderate levels of input, efficiency is highest. Because of this commonly found pattern, a non-linear correlation was computed on the relationship between content entropy and aggression.

The range of the entropy variable was divided into four approximately equal segments and dummy variables were created to represent each of these segments. If an individual's score on the entropy variable falls within a particular segment, the respondent is given a value of 1.00 for that variable. If the score is not within the range of a particular segment, the respondent is given a 0.00 value for the particular dummy variable. Each of

the four dummy variables representing the four segments of the range of entropy scores is entered into a multiple regression upon the dependent variable of overall aggression.[12]

The standardized beta weights for the dummy variables may then be used to determine the shape of the overall relationship between entropy and aggression, with assumptions of linearity operating only within each of the dummy variables, but not across the overall range represented by the contiguous dummy variables. The beta weights for the dummy variables appear in Table 2.

There is evidence to suggest that as entropy approaches lower limits of the range, aggression increases slightly, while at moderate ranges there is little relationship, and as entropy increases towards the upper end of the range, aggression increases again. The multiple R for the regression is .15 ($p<.05$). This indicates a higher capability for predicting aggression from content entropy with a U-shaped relationship than is possible with assumptions of linearity. However, the magnitude of the relationship still does not approach that reported by Krull and Watt using the form entropy measure with a linear analysis model. It would appear that the form measure still has higher predictive validity.

DISCUSSION

The first thing which merits discussion from the results is the extremely high mean content entropy value for the adolescent respondents. This would indicate that most of these people do not exhibit much selectivity in exposure to types of television programming. A reasonable generalization may be that they will watch nearly anything which happens to be on television at a particular time. The logic of the information theoretic measure would suggest that one would find it difficult to predict which type of program

a respondent will choose to watch within a particular time frame. This pattern of exposure, which is highly skewed and has low variance, makes it difficult to measure associations with criterion variables, since the exposure pattern is more like a constant than a variable. It is possible that this may partially account for the relatively low magnitude of the relationship found between content entropy and aggression.

As we indicated in an earlier section of this paper, it is important at these exploratory stages of the application of information theory to the measurement of various aspects of man's behavior with media to examine the predictive validity of alternative information theoretic measures. It is important to determine which measures offer the best predictive power at the lowest amount of effort required of the researcher to summarize the data in a particular way.

In this research we have tested one measure at a considerably higher level of abstraction than the measure of specific program entropy used by Watt and Krull. Although the measure requires substantially less effort to calculate than the form measure, it does not appear to offer the predictive validity which the form measure is reported to offer.

With regard to conceptual explanation, Krull and Watt argue that more entropic programs require more cognitive arousal to decode, and imply that this arousal will lead to higher rates of subsequent aggression in a linear fashion. The earlier work of Hanneman; using an experimental design including physiological measures of arousal rather than a cross-sectional survey data base with inferred arousal, also supports this proposition. However, it may be reasonable to assume that an important kind of arousal, possibly leading to aggression, occurs when the individual is exposed to <u>more</u> uncertainty than is preferred, as well as <u>less</u> uncertainty than is preferred.

Ashby's "Law of Requisite Variety"[13] posits that in order for a system to effectively reduce a level of uncertainty, it must have a corresponding level of uncertainty in its processing structures. Thus, when there is a lack of correspondence between the uncertainty in a pattern perceived in the environment and the uncertainty in cognitive information processing structures, creating an imbalance in either direction, stresses may be produced that may manifest in overt aggression. The representation of the relationship between message entropy and aggression would then be a U-shaped curve, and a linear model would be inappropriate to best measure the amount of covariation.

The apparent mildly U-shaped relationship between content entropy and aggression found in the present research adds some further evidence for a questioning of the linear assumption. However, it has not yet been determined whether this relationship would hold for the form measure of programming entropy. Thus, based on previous research and these preceding considerations, the linear model assumed by Watt and Krull may not be sound. In future research, it would be reasonable to explore the relationship between television message entropy and aggression, as well as other variables, with non-linear models. This may determine whether these means of summarizing data and abstracting relationships may yield more theoretically valuable results, enabling an integration of this research into other research viewing man as information processer.

Further exploratory work also needs to be done which examines other alternative measures of message entropy and gauges their relative theoretic utility. This may contribute to more rapid theoretical advancement which is needed in the mass communication area. Furthermore, other criterion variables in addition to the aggression variables may be useful to examine

with respect to message uncertainty. Perhaps the currently researched area most in need of more abstract, parsimonious, and predictive theory is the functions and gratifications of media use area.[14] Information processing models may provide valuable logics to explain variation in the reasons people attribute to their use of the media. In another paper the author explicates such a model in considerable detail.[15] However, a great deal of empirical work needs to be conducted to test these logics.

CONCLUSION

In this paper we have reviewed the use of information theory in the mass communication research area and suggested a framework for organizing entropy measures of media. An alternative measure of the entropy of media use to that used by Watt and Krull is tested on a comparable data base. Results indicate that the latter measure offers more apparent predictive utility in relationship to aggression. However, non-linear correlational techniques using the content entropy measure suggest that the linear models used by Krull and Watt may be inappropriate. Along other lines, the distribution of the content entropy measure indicates that the adolescent respondents in this sample exhibit very low amounts of selectivity in exposure to categories of programs. It is suggested the future research explore the utility of non-linear models and examine relationships between media message and exposure entropy and other criterion variables, most notably in the functions and gratifications of media use area.

NOTES

1. Jones and Gerard (1967); Miller (1971); Miller (1972); Katz and Kahn (1966); Buckley (1968) are some primary examples.

2. See Miller (1965) for an explication of some cross-level hypotheses which apply across biological and social systems. Miller cites evidence from a variety of biological and social research.

3. Notable examples are cybernetics, operations research, multidimensional modeling, computer based models of psychological processes, spectral analysis, non-linear regression models, etc.

4. A basic formula within information theory is $H = -\Sigma p_i \log_2 p_i$; where H is average information of uncertainty, and p_i is the relative probability of the occurrence of an alternative.

5. The greater the use of analogic vs. digital information processing, the greater the perceptual boundedness.

6. Social network integration is defined as the extent to which the primary friends with which a focal person communicates, communicate with each other. If all the primary friends of an individual communicate with each other, the person has a highly integrated social communication network. In the research cited here, the author asked respondents who their three best friends are, how much they communicate with them, and asked the respondent to estimate how frequently each of the friends communicate with each other.

7. See Weick (1969) for a more extensive discussion of this concept.

8. Watt and Krull (1972) discuss this distinction in the paper explicating their measures.

9. A secondary consideration is that Hanneman, in deleting scenes to create different levels of content uncertainty, also changed program form. However, this is not the primary focus of the measure.

10. The data set available to the author contained 22 less respondents than the sample size reported by Krull and Watt. However, with a large sample size such as this, this small discrepancy is not likely to introduce sizable differences in results. At the time of writing, the author was not able to determine the reasons for this discrepancy.

11. For examples of U-shaped relations found empirically, see Schroder, Driver, and Streufert (1967), Eckblad (1963), Munsinger and Kessen (1964), Dorfman and McKenna (1966), Rump (1968), McNeil and Rule (1970), Swartz and Herbik (1971).

12. See Kerlinger and Pedhazur (1973) for a discussion of these analysis techniques. Since with a dummy variable coding, the value of the last variable is always known based on knowledge of the previous dummy variables, four are necessary to determine a quadratic curve defined by three points. Only three variables then operate in a regression upon the dependent variable.

13. See Ashby's article: "Variety, Constraint, and the Law of Requisite Variety" in Buckley (1968), p. 129-137.

14. For a review of functions and gratifications conceptualization and research, see Katz, Blumler, and Gurevitch (1974).

15. See Danowski (1974).

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Figure 1. Matrix of Entropy Measures of Television Messages

LEVEL OF ABSTRACTION	LOCUS OF DEFINITION: Source	LOCUS OF DEFINITION: Receiver
Form	Watt and Krull (1972) Krull and Watt (1973) Wartella and Ettema (1973	
Content		Hanneman (1970) Danowski (1974b)
Channel		Danowski (1974a)

Table 1

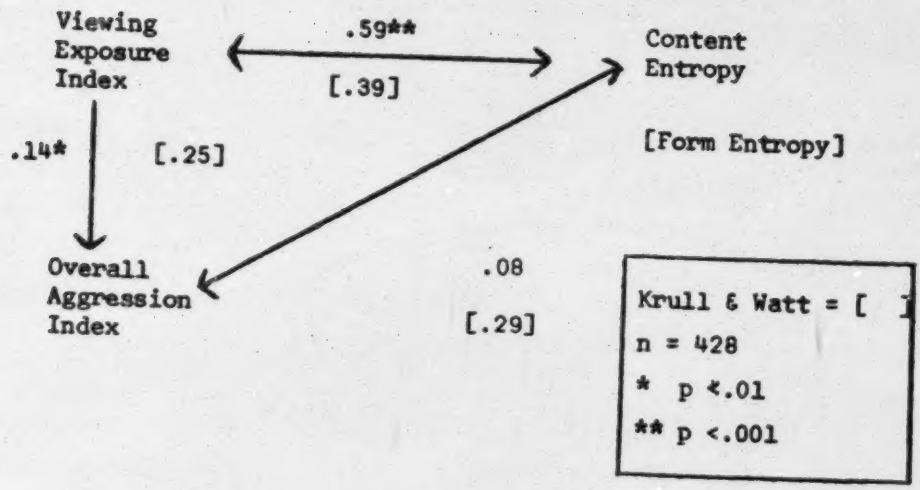
Descriptive Statistics

VARIABLE	MEAN	S.D.
Entropy	.91	.11
Viewing Exposure	116.07	47.95
Aggression	30.57	56.94

n = 428

Figure 1

ZERO-ORDER CORRELATIONS



FIRST-ORDER PARTIAL CORRELATIONS

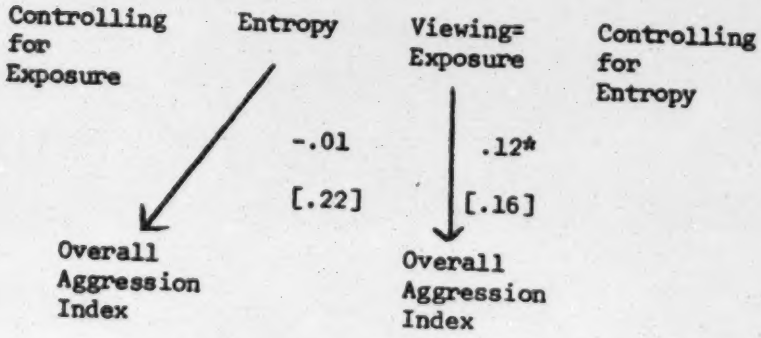


Table 2

Non-Linear Regression

Dependent Variable: Overall Aggression

Multiple R

.15 $p<.05$

Variable	Beta
Dum 1	-.07
Dum 2	-.03
Dum 4	.11

APPENDIX A

Program Categories*

Crime-Detective
(11 programs)

Mod Squad
Hawaii Five-O
Ironside
It Takes a Thief
Get Smart
Name of the Game
Dragnet
Adam-12
Mannix
The FBI
Mission Impossible

(weight = 2.27)

Westerns
(7 programs)

Gunsmoke
Lancer
Virginian
Daniel Boone
Here Come the Brides
High Chapparal
Bonanza

(weight = 3.57)

Adventure-Drama
(6 programs)

Marcus Welby
Medical Center
Bronson
Hogan's Heroes
Land of the Giants
World of Disney

(weight = 4.17)

Comedy-Variety
(14 programs)

Laugh-In
Carol Burnett
Red Skelton
Hee Haw
Johnny Cash
Pat Paulson
Jim Nabors
Tom Jones
Dean Martin
Jackie Gleason
Andy Williams
Lawrence Welk
Ed Sullivan
Glen Campbell

(weight = 1.78)

Game Shows
(2 programs)

Let's Make a Deal
Newlywed Game

(weight = 12.50)

Situation Comedy
(25 programs)

My World
Here's Lucy
Jeannie
Debbie Reynolds
Julia
Governor and J.J.
Nanny and the Professor
Eddie's Father
Beverly Hillbillies
Room 222
Family Affair
That Girl
Bewitched
Flying Nun
Tim Conway
Brady Bunch
Ghost and Mrs. Muir
Love American Style
My Three Sons
Green Acres
Petticoat Junction
To Rome with Love
Bill Cosby
Mayberry R.F.D.
Doris Day

(weight = 1.00)

* Scoring--"almost always" (4)
"often" (3)
"sometimes" (2)
"never" (0)